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Refrigerating machine oils

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Contents

	Page
Introduction.....	1
1 Scope.....	1
2 Normative references	1
3 Terms and definitions	2
4 Classification	3
5 Quality	4
6 Test method.....	9
6.1 Sampling method.....	9
6.2 Kinematic viscosity	9
6.3 Colour	9
6.4 Flash point.....	9
6.5 Pour point.....	9
6.6 Low temperature precipitation property.....	10
6.7 Acid number	10
6.8 Copper strip corrosion.....	10
6.9 Chemical stability to refrigerant.....	10
6.10 Dielectric breakdown voltage	10
6.11 Water content.....	10
6.12 Compatibility with refrigerant	10
7 Designation of product.....	10
8 Marking.....	10
Annex A (normative) Testing method for low temperature precipitation property.....	11
Annex B (normative) Testing method for chemical stability to refrigerant (sealed tube test)	15
Annex C (normative) Testing method for chemical stability to refrigerant (autoclave test)	26
Annex D (normative) Testing method for compatibility with refrigerant	31

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Lubricating Oil Society (JALOS)/ Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS K 2211:1992** has been replaced with this Standard.

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Refrigerating machine oils

Introduction

This Japanese Industrial Standard was established in 1956 and has gone through seven revisions to this day, the most recent of which was taken place in 1992. Afterwards, CFC-12 (Freon 12) and CFC-22 (Freon 22) specified as the refrigerant to be used have become subject to CFC restriction, and the corresponding **JISs** have been withdrawn. According to this, **JIS K 1560** has been established as the new standard of refrigerant, and the revision of this time is to correspond to this modification.

The corresponding International Standard has not yet been published at this moment, but the first edition of **ISO 6743-3** published in 2003 has been referred to for the classification of refrigerating machine oils.

Warning: The use of this Standard may involve hazardous materials, operations and equipment. This Standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This Standard specifies the refrigerating machine oils to be used as the lubricating oils for refrigerators.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) listed below shall be applied.

JIS B 7410 *Liquid-in-glass thermometers for testing of petroleum product*

JIS C 2101 *Testing methods of electrical insulating oils*

JIS C 2504 *Soft magnetic irons*

JIS C 3102 *Annealed copper wires for electrical purposes*

JIS H 4040 *Aluminium and aluminium alloy rods, bars and wires*

JIS K 1560 *1,1,1,2-Tetrafluoroethane (HFC-134a)*

JIS K 2001 *Industrial liquid lubricants—ISO viscosity classification*

JIS K 2251 *Crude petroleum and petroleum products—Sampling*

JIS K 2265-4 *Determination of flash points—Part 4: Cleveland open cup method*

JIS K 2269 *Testing methods for pour point and cloud point of crude oil and petroleum products*

JIS K 2275 *Crude oil and petroleum products—Determination of water content*

JIS K 2283 *Crude petroleum and petroleum products—Determination of kinematic viscosity and calculation of viscosity index from kinematic viscosity*

- JIS K 2501 *Petroleum products and lubricants—Determination of neutralization number*
- JIS K 2513 *Petroleum products—Corrosiveness to copper—Copper strip test*
- JIS K 2580 *Petroleum products—Determination of colour*
- JIS R 6251 *Abrasive cloths*
- JIS Z 8401 *Guide to the rounding of numbers*
- JIS Z 8402-6 *Accuracy (trueness and precision) of measurement methods and results—Part 6: Use in practice of accuracy values*

3 Terms and definitions

For the purposes of this Standard, the following terms and definitions shall apply.

3.1 HFC

the abbreviation of hydrofluorocarbon

3.2 incompatible refrigerating machine oil

refrigerating machine oil not dissolved in a refrigerant approximately in the whole range of the test temperature but separated into two layers of a refrigerant layer and a refrigerating machine oil layer

3.3 compatible refrigerating machine oil

refrigerating machine oil dissolved in a refrigerant in the partial range or the whole range of the test temperature and become a homogenous liquid of one layer

3.4 low temperature precipitation property

property causing the phenomenon in which components contained or contaminated in a refrigerating machine oil will precipitate in capillary, granular, cloudy or turbidness state before the two-layer separation temperature reaches when a refrigerant and a compatible refrigerating machine oil are mixed then cooled

3.5 chemical stability to refrigerant

chemical stability when a refrigerant and a refrigerating machine oil are subjected to the deterioration by heating at a constant temperature for a constant period under the mixed condition

3.6 compatibility with refrigerant

property in which a refrigerating machine oil is dissolved in a refrigerant

When a refrigerant and a refrigerating machine oil are mixed and they become a homogenous liquid of one layer, the refrigerating machine oil is expressed as compatible with the refrigerant mixed.

3.7 two-layer separation temperature

temperature to make the two-layered separation condition in which a refrigerant and a refrigerating machine oil are mixed but separated into the state of two layers or emulsion without dissolving each other

4 Classification

The classification of refrigerating machine oils shall be in accordance with table 1. They shall be classified according to the applicable compressor, application division, viscosity grade and supplementary viscosity grade specified in **JIS K 2001**.

Table 1 Classification of refrigerating machine oil

Classification	Symbol ^{a)}	Application division	Viscosity grade	Application example
Type 1 For compressor of electric refrigerator	Type 1C	Incompatible refrigerating machine oil for HFC refrigerant	ISO VG 5 ISO VG 7 ISO VG 10 ISO VG 15	Refrigerator, freezing/refrigerating showcase, automatic vending machine, etc.
	Type 1D	Compatible refrigerating machine oil for HFC refrigerant	ISO VG 22 ISO VG 32 ISO VG 46 ISO VG 68	
	Type 1F	Compatible refrigerating machine oil for carbon dioxide refrigerant	VG 6 VG 8 VG 12 VG 18	
	Type 1G	Compatible refrigerating machine oil for hydrocarbon refrigerant	VG 26 VG 38 VG 56	
Type 2 For compressor of car air-conditioner	Type 2D	Compatible refrigerating machine oil for HFC refrigerant	ISO VG 32 ISO VG 46 ISO VG 68 ISO VG 100 ISO VG 150	Car air-conditioner, etc.
	Type 2F	Compatible refrigerating machine oil for carbon dioxide refrigerant	ISO VG 220 ISO VG 320 ISO VG 460 VG 56 VG 83	
Type 3 For compressor of heat pump	Type 3C	Incompatible refrigerating machine oil for HFC refrigerant	ISO VG 15 ISO VG 22 ISO VG 32	Room air-conditioner, packaged air-conditioner, water heater, dehumidifier, etc.
	Type 3D	Compatible refrigerating machine oil for HFC refrigerant	ISO VG 46 ISO VG 68 ISO VG 100 ISO VG 150	
	Type 3F	Compatible refrigerating machine oil for carbon dioxide refrigerant	ISO VG 220 ISO VG 320 VG 26	
	Type 3G	Compatible refrigerating machine oil for hydrocarbon refrigerant	VG 38 VG 56 VG 260	

Table 1 (concluded)

Classification	Symbol ^{a)}	Application division	Viscosity grade	Application example
Type 4 For general industrial refrigerating machine (refrigerant other than ammonia)	Type 4C	Incompatible refrigerating machine oil for HFC refrigerant	ISO VG 15 ISO VG 22 ISO VG 32	Condensing unit, freezing/refrigerating unit, etc.
	Type 4D	Compatible refrigerating machine oil for HFC refrigerant	ISO VG 46 ISO VG 68 ISO VG 100	
	Type 4F	Compatible refrigerating machine oil for carbon dioxide refrigerant	ISO VG 150 ISO VG 220 ISO VG 320	
	Type 4G	Compatible refrigerating machine oil for hydrocarbon refrigerant	VG 26 VG 56 VG 260	
Type 5 For general industrial refrigerating machine (refrigerant of ammonia)	Type 5A	Incompatible refrigerating machine oil for ammonia	ISO VG 32 ISO VG 46 ISO VG 68	Condensing unit, freezing/refrigerating unit, etc.
	Type 5B	Compatible refrigerating machine oil for ammonia	ISO VG 100 VG 26 VG 56	
Note ^{a)} To correspond to the refrigerating machine oils used for the refrigerant containing chlorine, Type 1E, Type 2E, Type 3E and Type 4E may be added to Type 1 to Type 4.				

5 Quality

Refrigerating machine oils shall be refined mineral oils, synthetic oils ¹⁾ or their mixtures, or the oils above-mentioned with additives. They shall contain no visible water or precipitates, and shall meet the requirements specified in table 2 for Type 1, table 3 for Type 2, table 4 for Type 3, table 5 for Type 4 and table 6 for Type 5 when tested in accordance with clause 6.

For the oils in the boundary of two viscosity grades of kinetic viscosity at 40 °C, these two viscosity grades may be marked. However, for the other qualities than the kinetic viscosity, the severer side of column shall be applied.

Note ¹⁾ They shall be those of alkylbenzene, polyalkylene glycol, poly-alpha-olefin, polyol ester, poly vinyl ether, etc. as the main component.

Table 2 Required quality for Type 1 refrigerating machine oil

Viscosity grade	Kinematic viscosity (40 °C) mm ² /s	Colour (ASTM)	Flash point °C	Pour point °C	Low temperature precipitation property ^{a)} (sample of 10 % in mass fraction and refrigerant of 90 % in mass fraction) °C	Acid number ^{b)} mgKOH/g	Copper strip corrosion (100 °C, 3 h)	Chemical stability to refrigerant ^{c)} (175 °C, 14 days) Colour (ASTM)	Dielectric breakdown voltage kV	Water content ^{d)} mg/kg
ISO VG 5	4.14 or over to and incl. 5.06	1.0 max.	100 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
ISO VG 7	6.12 or over to and incl. 7.48	1.0 max.	120 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
ISO VG 10	9.00 or over to and incl. 11.0	1.0 max.	140 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
ISO VG 15	13.5 or over to and incl. 16.5	2.0 max.	140 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
ISO VG 22	19.8 or over to and incl. 24.2	2.5 max.	155 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
ISO VG 32	28.8 or over to and incl. 35.2	2.5 max.	160 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
ISO VG 46	41.4 or over to and incl. 50.6	3.0 max.	165 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
ISO VG 68	61.2 or over to and incl. 74.8	3.5 max.	165 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
VG 6	Over 5.06 to and excl. 6.12	1.0 max.	110 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
VG 8	Over 7.48 to and excl. 9.00	1.0 max.	130 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
VG 12	Over 11.0 to and excl. 13.5	2.0 max.	140 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
VG 18	Over 16.5 to and excl. 19.8	2.5 max.	140 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
VG 26	Over 24.2 to and excl. 28.8	2.5 max.	155 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
VG 38	Over 36.2 to and excl. 41.4	3.0 max.	160 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
VG 56	Over 50.6 to and excl. 61.2	3.0 max.	165 min.	-27.5 max.	-40 max.	—	1 max.	5.0 max.	25 min.	50 max.
Notes ^{a)} Applicable only to Type 1D and Type 1E. ^{b)} Upon the agreement between the parties concerned with delivery. ^{c)} The shield tube test shall be applicable only to Type 1D and Type 1E. ^{d)} Applicable to the mineral oils and not to the synthetic oils. The synthetic oils shall be upon the agreement between the parties concerned with delivery.										

Table 3 Required quality for Type 2 refrigerating machine oil

Viscosity grade	Kinematic viscosity (40 °C) mm ² /s	Colour (ASTM)	Flash point °C	Pour point °C	Acid number ^{a)} mgKOH/g	Copper strip corrosion (100 °C, 3 h)	Chemical stability to refrigerant ^{b)} (175 °C, 14 days) Colour (ASTM)		Dielectric breakdown voltage ^{c)} kV	Water content ^{d)} mg/kg
							Type 2E	Type 2D, Type 2F		
ISO VG 32	28.8 or over to and incl. 35.2	2.5 max.	160 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
ISO VG 46	41.4 or over to and incl. 50.6	3.0 max.	165 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
ISO VG 68	61.2 or over to and incl. 74.8	3.5 max.	165 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
ISO VG 100	90.0 or over to and incl. 110	3.5 max.	180 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
ISO VG 150	135 or over to and incl. 165	3.5 max.	180 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
ISO VG 220	198 or over to and incl. 242	3.5 max.	180 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
ISO VG 320	288 or over to and incl. 352	3.5 max.	180 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
ISO VG 460	414 or over to and incl. 506	4.0 max.	180 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
VG 56	Over 50.6 to and excl. 61.2	3.0 max.	165 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
VG 83	Over 74.8 to and excl. 90.0	3.5 max.	170 min.	-10.0 max.	—	1 max.	8.0 max.	5.0 max.	25 min.	50 max.
Notes ^{a)} Upon the agreement between the parties concerned with delivery. ^{b)} The shield tube test shall be applicable only to Type 2D and Type 2E. ^{c)} Applicable only to the compressor for motor car air-conditioner. ^{d)} Applicable to the mineral oils and not to the synthetic oils. The synthetic oils shall be upon the agreement between the parties concerned with delivery.										

Table 4 Required quality for Type 3 refrigerating machine oil

Viscosity grade	Kinematic viscosity (40 °C) mm ² /s	Colour (ASTM)	Flash point °C	Pour point °C	Low temperature precipitation property ^{a)} (sample of 10 % in mass fraction and refrigerant of 90 % in mass fraction) °C	Acid number ^{b)} mgKOH/g	Copper strip corrosion (100 °C, 3 h)	Dielectric breakdown voltage kV	Compatibility to refrigerant for two-layer separation temperature ^{c)} (sample of 15 % in mass fraction and refrigerant of 85 % in mass fraction) °C	Water content ^{d)} mg/kg
ISO VG 15	13.5 or over to and incl. 16.5	2.0 max.	140 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 22	19.8 or over to and incl. 24.2	2.5 max.	155 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 32	28.8 or over to and incl. 35.2	2.5 max.	160 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 46	41.4 or over to and incl. 50.6	3.0 max.	165 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 68	61.2 or over to and incl. 74.8	3.5 max.	165 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 100	90.0 or over to and incl. 110	3.5 max.	180 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 150	135 or over to and incl. 165	3.5 max.	180 min.	-20.0 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 220	198 or over to and incl. 242	3.5 max.	180 min.	-20.0 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
ISO VG 320	288 or over to and incl. 352	3.5 max.	180 min.	-20.0 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
VG 26	Over 24.2 to and excl. 28.8	2.5 max.	155 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
VG 38	Over 35.2 to and excl. 41.4	3.0 max.	160 min.	-10.0 max.	No spec.	—	1 max.	25 min.	No spec.	50 max.
VG 56	Over 50.6 to and excl. 61.2	3.0 max.	165 min.	-27.5 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
VG 260	Over 242 to and excl. 288	3.5 max.	180 min.	-20.0 max.	-30 max.	—	1 max.	25 min.	20 max.	50 max.
Notes ^{a)} Applicable only to Type 3E. ^{b)} Upon the agreement between the parties concerned with delivery. ^{c)} Applicable only to Type 3D and Type 3E. ^{d)} Applicable to the mineral oils and not to the synthetic oils. The synthetic oils shall be upon the agreement between the parties concerned with delivery.										

Table 5 Required quality for Type 4 refrigerating machine oil

Viscosity grade	Kinematic viscosity (40 °C) mm ² /s	Colour (ASTM)	Flash point °C	Pour point °C	Low temperature precipitation property ^{a)} (sample of 10 % in mass fraction and refrigerant of 90 % in mass fraction) °C	Acid number ^{b)} mgKOH/g	Copper strip corrosion (100 °C, 3 h)	Dielectric breakdown voltage ^{c)} kV	Water content ^{d)} mg/kg
ISO VG 15	13.5 or over to and incl. 16.5	2.0 max.	140 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 22	19.8 or over to and incl. 24.2	2.5 max.	155 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 32	28.8 or over to and incl. 35.2	2.5 max.	160 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 46	41.4 or over to and incl. 50.6	3.0 max.	165 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 68	61.2 or over to and incl. 74.8	3.5 max.	165 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 100	90.0 or over to and incl. 110	3.5 max.	180 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 150	135 or over to and incl. 165	3.5 max.	180 min.	-20.0 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 220	198 or over to and incl. 242	3.5 max.	180 min.	-20.0 max.	-45 max.	—	1 max.	25 min.	50 max.
ISO VG 320	288 or over to and incl. 352	3.5 max.	180 min.	-20.0 max.	-45 max.	—	1 max.	25 min.	50 max.
VG 26	Over 24.2 to and excl. 28.8	2.5 max.	155 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
VG 56	Over 50.6 to and excl. 61.2	3.0 max.	165 min.	-27.5 max.	-45 max.	—	1 max.	25 min.	50 max.
VG 260	Over 242 to and excl. 288	3.5 max.	180 min.	-20.0 max.	-45 max.	—	1 max.	25 min.	50 max.
Notes ^{a)} Applicable only to Type 4D and Type 4E. Applicable only when used for the refrigerator of -40 °C or under in vaporization temperature. No specification for others. ^{b)} Upon the agreement between the parties concerned with delivery. ^{c)} Applicable only when used for the closed and semi-closed type refrigerator. No specification for others. ^{d)} Applicable to the mineral oils and not to the synthetic oils. The synthetic oils shall be upon the agreement between the parties concerned with delivery.									

Table 6 Required quality for Type 5 refrigerating machine oil

Viscosity grade	Kinematic viscosity (40 °C) mm ² /s	Colour (ASTM)	Flash point °C	Pour point °C	Acid number ^{b)} mgKOH/g	Copper strip corrosion (100 °C, 3 h)	Water content ^{c)} mg/kg
ISO VG 32	28.8 or over to and incl. 35.2	2.5 max.	160 min.	-32.5 max.	—	1 max.	50 max.
ISO VG 46	41.4 or over to and incl. 50.6	3.0 max.	165 min.	-32.5 max.	—	1 max.	50 max.
ISO VG 68	61.2 or over to and incl. 74.8	3.5 max.	165 min.	-32.5 max.	—	1 max.	50 max.
ISO VG 100	90.0 or over to and incl. 110	3.5 max.	180 min.	-32.5 max. ^{a)}	—	1 max.	50 max.
VG 26	Over 24.2 to and excl. 28.8	2.5 max.	155 min.	-32.5 max.	—	1 max.	50 max.
VG 56	Over 50.6 to and excl. 61.2	3.0 max.	165 min.	-32.5 max.	—	1 max.	50 max.
Notes ^{a)} Not applicable to the mineral oils. ^{b)} Upon the agreement between the parties concerned with delivery. ^{c)} Applicable to the mineral oils and not to the synthetic oils. The synthetic oils shall be upon the agreement between the parties concerned with delivery.							

6 Test method

6.1 Sampling method

The sampling method shall be in accordance with **JIS K 2251**. In addition, the sampling for the dielectric breakdown voltage test and the water content test shall be in accordance with the following.

- The sampling apparatus and the sample container dried thoroughly shall be used.
The inside of the sample container shall preliminarily be replaced with dry nitrogen gas, as necessary.
- The sample container shall be filled with the sample completely without no vacant space, and sealed immediately.

6.2 Kinematic viscosity

The kinematic viscosity shall be determined by the kinematic viscosity testing method specified in **JIS K 2283**.

6.3 Colour

The colour shall be determined by the ASTM colour testing method specified in **JIS K 2580**.

6.4 Flash point

The flash point shall be determined in accordance with **JIS K 2265-4**.

6.5 Pour point

The pour point shall be determined by the pour point testing method specified in **JIS K 2269**.

6.6 Low temperature precipitation property

The low temperature precipitation property shall be in accordance with Annex A.

6.7 Acid number

The acid number shall be determined by the indicator titration method or the potentiometric titration method specified in **JIS K 2501**.

6.8 Copper strip corrosion

The copper strip corrosion shall be determined in accordance with **JIS K 2513**.

6.9 Chemical stability to refrigerant

The chemical stability to refrigerant shall be in accordance with Annex B or Annex C.

6.10 Dielectric breakdown voltage

The dielectric breakdown voltage shall be determined by the dielectric breakdown voltage testing method specified in **JIS C 2101**.

6.11 Water content

The water content shall be determined by the Carl Fischer volumetric titration method or the Carl Fischer coulometric titration method specified in **JIS K 2275**.

6.12 Compatibility with refrigerant

The compatibility with refrigerant shall be in accordance with Annex D.

7 Designation of product

The designation of product shall be in accordance with the name, symbol of type and viscosity grade (see example 1).

Example 1 Refrigerating machine oil Type 1D ISO VG 10
Refrigerating machine oil Type 1D 10 (abbreviation) is acceptable.

The product to which two viscosity grades are marked shall be as follows (see example 2).

Example 2 Refrigerating machine oil Type 2D ISO VG 46/VG 56
Refrigerating machine oil Type 2D 46/56 (abbreviation) is acceptable.

8 Marking

The following items shall be marked on an easily visible position of the container by an indelible means. If such marking is difficult, for example, for tank cars, tankers, tanker lorries, etc., they may be marked on the invoice.

- a) Number and title of this Standard
- b) Symbol of type and viscosity grade
- c) Net volume
- d) Name of manufacturer or its abbreviation
- e) Date of manufacture or its abbreviation